# **Groundwater and Wells** An Overview for a Well Owner or Well Operator







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# Common Groundwater Well Problems





## Water quantity:

- Low well yields
- Well interference
- Seasonal water shortages
- Aquifer over use and depletion

## Water quality:

- Natural minerals
- Land use practices (manure, sewerage systems, pesticides)
- Wells:
  - Inactive or abandoned
  - Poor construction, maintenance and /or operation
  - Casing failure
  - Biofouling
  - Mineral incrustation
  - Sediment plugging



## Groundwater Myth vs Fact



Myth: Groundwater is not a significant source of water supply. Fact: 1% of water is useable; 99% of which is groundwater

Myth: Groundwater has few uses.

Fact: water supply systems, geothermal, irrigation, livestock, mining, manufacturing

Myth: there is a lake or river beneath our feet

Fact: Groundwater fills the pores and fissures of the substrate material

Myth: Groundwater moves rapidly

Fact:

- Groundwater rates measured feet or centimeters per day/month/year or decade
- Surface water rates feet or centimeters per second/day

## Groundwater Myth vs Fact

**Myth:** Lots of water. Therefore, doesn't need to be conserved.

## Fact:

- Pumping groundwater at a rate greater than the rate of recharge replenishment, deletes aquifer storage capacity resulting in serious groundwater mining.
- Conserve to maintain water quantity



Photo: Dr. Joseph R. Poland, USGS, Public Domain



## Subsidence Fact:

- Ottawa subdivision, 1970's
- Parts of Mexico City, 10 meters in 70 years
- USGS 80% of identified subsidence from exploitation of groundwater (California, New Hampshire, Vermont, Southwest)

# Groundwater

Hydrologic Cycle



#### Hydrologic Cycle

The amount of water on Earth remains constant.

#### Groundwater

- Collects in substrate spaces
- Travel or be absorbed
- Pumped to surface

# **BC Interior Aquifers**





- Geological formation that contains groundwater
- Aquifer material type, grain size and porosity affect quantity and quality.
- Ground surface and subsurface material permeability affects:
  - Precipitation infiltration rate,
  - Storage capability,
  - Rate of contamination movement.





Water between Sand Grains

Water in Rock Fractures

Schematic Credits: Natural Resources Canada

# Aquifers

#### **Aquifer Resources:**

- Aquifer Classification System (<u>https://www2.gov.bc.ca/gov/co</u> <u>ntent/environment/air-land-</u> <u>water/water/groundwater-</u> <u>wells-aquifers/understanding-</u> <u>aquifers</u>)
- Mapping Programs:
  - BC Water Resource Atlas
  - iMap
- Aquifer Search: GWELLS

(https://apps.nrs.gov.bc.ca/gwells /)



#### COLUMBLA Groundwater Wells and Aquifers

#### Well Search Aquifer Search Registry Search Groundwater Information

# Aquifer Search / Aquifer Summary Aquifer 1384 Summary Aquifer number 384 Year of mapping 2000 Aquifer number 2000 Aquifer number 2000 Aquifer number 100 Descriptive location 150 Mille House, B. C. C. Whenshilty Low Subtype Confined sand and gravel-g Quality concerns None Productivity Moderate

Size (km²) Calculated well density €



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wen mio rast updated 2/15/2022		(annual)		Water budget	No information available.
Documentation		Licensed volume by purpose (mil	llions of cubic meters)	Hydraulically connected (screening level) O	Less likely
Factsheets <ul> <li>AQ_00384_Aquiler_Factsheet.</li> </ul>	pdf	Camp	s & Public Facilities <0.01	Groundwater Surface Water Interactions	No information available.
Other Documents				Other information	No information available.
AO 00384 Amilier Manning	Report off				



## Well Reports - Well Registration – Water License

- Do you have a copy of your well record (construction report)?
- Is your well registered? Record available in GWELLS (<u>https://apps.nrs.gov.bc.ca/gwells/</u>)
- Submission of well records mandatory, March 1, 2016.
  - Responsibility for drilled well well driller
  - Responsibility for dug well well owner
- Contact groundwater@gov.bc.ca
- Water License mandatory for groundwater use, March 1, 2016
  - Exception: Domestic Use (single family dwelling)
  - (<u>https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-licensing-rights</u>)
  - Contact FrontCounter BC (<u>https://portal.nrs.gov.bc.ca/web/client/contact</u>)
  - BCeID recommended (<u>https://www.bceid.ca/</u>)
  - Not a Health Authority Well Construction Permit

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(or) PID: <u>181771</u>	042	_ (and)	Description of w	all location (attach sket	ich, if nec.):		
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## Key Resource – GWELLS Aquifers – Wells- Registry



Groundwater Wells and Aquifers <u>https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/groundwater-wells-aquifers</u> Provincial database: GWELLs <u>https://apps.nrs.gov.bc.ca/gwells/</u>

BRITISH Groundwater Wells and A	quifers	Log in		water Wells ar	nd Aquifers			Log in
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Please note, well registration and groundwater use licensing are different. Ye water licence. Contact FrontCounter BC at 1-877-855-3222.	our well has been registered if you can locate it using this tool. Non-domestic groundwater us	se requires a	Well Summary				For best print results, use the	Chrome browser 🔒
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Basic Search     Advanced Search       Search by well tag or ID plate number, street address, city or owner name ?			Location Information Well Activity Well Work Dates Well Completion Data and Artesian Flow Lithology Licensing Information		Casing Details Surface Seal and Backfill Details Liner Details Screen Details Well Development		Well Yield Well Decommissioning Comments Disclaimer	
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## Key Resource – GWELLS Aquifers – Wells- Registry



#### BRITISH COLUMBIA Groundwater Wells and Aquifers

Well Search Aquifer Search Registry Search Groundwater Information

#### Search for a Well Driller or Well Pump Installer

To update contact information or for general enquiries email groundwater@gov.bc.ca.

Learn more about registering as a well driller or well pump installer in B.C.

Choose professional type:

Well Driller
 Well Pump Installer

#### Community:

All	
BC	
100 Mile House	
150 Mile House	
Abbotsford	
Aldergrove	

#### Individual, company, or registration number

Search		

Entries:

10 🗸

#### Well Driller Results

To update contact information email groundwater@gov.bc.ca.

Name 🗢	Company Name	Company Address	Contact Information	Class of Driller	Certificate Issued By
Barling, Chris WD 09032301	Wild West Drilling Inc.	1063 Simmons Road Creston, BC V0B 1G7	Phone: (250) 428-0137 Email: wildwestdrilling@gmail.com	Water Well Driller Geotechnical/Environmental Driller Geoexchange Driller	Water Well Driller Certificate - BC Water Well Driller Certificate - BC Water Well Driller Certificate - BC
Randall, Matthew WD 17081801	Wild West Drilling Inc.	1063 Simmons Road Creston, BC V0B 1G7	Phone: (250) 428-0137 Email: wildwestdrilling@gmail.com	Water Well Driller	Water Well Driller Certificate - BC

Showing 1 to 2 of 2

Previous Net

# Water Sustainability Act (WSA) Restricted Activity



WSA (s. 49, 50) restricts well construction, decommissioning and pump installation Well Driller (WD) and Well Pump Installer Registry GWELLS Registry Search (https://apps.nrs.gov.bc.ca/gwells/registries)



- WD & WPI roles and responsibilities
- Minimum standards for well construction, decommissioning and reporting
- Flowing artesian well requirements
- Minimum standards for well pumps

JOHN SM	NITH
is a well driller who is o	qualified in the
Province of British Colu	mbia under the
Water Ac	t



# Components of a Well





- 1. Borehole
- 2. Casing
- 3. Surface Seal
  - Prevents contamination from surface
  - Prevents mixing of aquifers
- 4. Well Intake Screen or Slotted liner
- 5. Pitless Adaptor
- 6. Pump
  - Properly matched to recommended pumping

rate

7. Well Cap

Schematic Credit: BC LWRS



## Why hire a well driller or pump installer? Protect groundwater resource

Photo: L









## Well Location Water quantity and quality impacts



WRIBILIA

#### What to consider:

- Sources of contamination (30 m and 3 m)
- Power lines and power pole location (20 m)
- Buildings (6 m)
- Surface water (30 m)
- Other wells (15 m)





# What Kind of Well do I have?



Abandoned or Inactive Well

Dug Well

Drilled Well in a Pit or Vault

Drilled Well

## Inactive or Abandoned Wells Water quality impacts





- Must maintain until decommission
- Decommission deactivated wells after 5 years
- Hire well driller or well pump installer









# Types of Wells – Construction Standards

#### Dug Well:

- Large Diameter
- Shallow
- Construction by well owner, excavation contractor
- Pump installation by registered well pump installer (GWELLS Registry - <u>https://apps.nrs.gov.bc.ca/gwells/</u>)





# **Drilled Bedrock Wells**



- Generally deeper with low water yields
- Recommend PVC well liner
- Well drawdown should not be into or past water fracture zones
- Air in fracture zone will cause a change in water chemistry:
  - Natural mineral concentrations
  - Bacterial growth
  - Increase precipitate formation





# Well In Pits







- Water must not pond around the wellhead.
- Encourage well owners to bring wells in pits above ground surface
- Must not construct a well pit for a new or altered well.

Exemption:

- Professional designs pit and oversees construction.
- Design & as-built drawings submitted to the comptroller for approval before construction begins





# Remove a Well from a Pit or Vault



- Hire a well driller or well pump installer.
- Confined space entry certification.
- Remove well pit cribbing.
- Extend well casing above ground level.
- Install a pitless adapter.
- Install surface seal.
- Fill.
- Graded wellhead.
- Attach well id plate.
- Brochure on website (<u>https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/water-water/water-wells/upgrading\_wells\_in\_pits.pdf</u>)



# **Surface Seals**



- Effective, permanent, continuous.
- For water supply wells, 5m in length or as long as possible up to 5m.
- Dug well 5 m surface seal length or to the greatest possible length.
- 2.54 cm thickness.
- Within 0.3 m of the ground surface.
- Well owner responsibility to maintain the surface seal by contacting WPI or WD.









## Well Caps and Covers Secure and vermin proof















Photo: L. Lyons





## Well Casing Continuous with 0.3m stick-up







# Wellhead Accessible and Protected





- Physical damage
- UV damage
- Contaminants











## Wellhead Accessible and Protected? Protection of your groundwater source







# **Well Legislation Summary**



Store contaminants >3m away

Protect casing stickup from damage

Keep ground sloped so water runs away



Maintain clear access to wellhead

Replace ID plate if lost or damaged

Fill any visible annular space with sealant

# Flowing Artesian Well

Water Quantity Impacts

## **Artesian Flow**



Must be constructed and decommissioned by a water well driller.

An uncontrolled flowing artesian well:

- Wastes water
- May cause flooding damage and/or subsidence
- May lower the confining pressure and affect neighbouring wells, springs and nearby streams.







# Flowing Artesian Wells



## WSA s 52 (1) "Under Control" when the artesian flow:

- Clear of sediment
- Entirely conveyed through casing
- Can be mechanically stopped
- Does not pose a threat to property, public safety or the environment







## Flowing Artesian Wells What You Can Do



- Well owner's responsibility to:
  - Hire a water well driller or professional.
  - Does the well driller have experience to stop/control a flowing artesian well?
  - Ensure artesian flow is stopped and controlled or well decommissioned or alternate specification submitted and approved.
  - Understand maintenance, operational requirements, regular inspections of equipment (wellhead, pressure gauge, backflow preventor)
- These wells are under pressure.

#### **Resources:**

Brochure

(<u>https://www2.gov.bc.ca/assets/gov/en</u> <u>vironment/air-land-water/water/water-</u> <u>wells/flowing\_artesian\_wells.pdf</u>)

Well Drilling Advisory: (https://www2.gov.bc.ca/gov/content/ environment/air-landwater/water/groundwater-wellsaquifers/groundwater-wells/informationfor-well-drillers-well-pump-installers/welldrilling-advisories)

# **Aquifer Depletion**



- Aquifer water demand increase
  - Regional decline in well static water level
- Groundwater is removed faster than being recharged
  - Why? Overuse, drought, climate change, or flowing artesian wells
- Drop in well yield is not always due to aquifer depletion



 State of Environment Report (<u>https://www2.gov.bc.ca/gov/con</u> <u>tent/environment/research-</u> <u>monitoring-</u> <u>reporting/reporting/environmental-</u> <u>reporting-bc</u>)



## Well Interference Water quantity



- Occurs when large volumes are pumped resulting in water loss for neighbouring wells.
- Over-pumping causes premature pump and well failure.
- Increases rate of corrosion, incrustation, biofouling and sediment movement.
- Accentuated by:
  - dry conditions, drought
  - Dewatering of bedrock microfractures
- **GWPR s 18** wells must be 15 m apart (alternate specifications)





## Aquifer Depletion / Well Interference What You Can Do



- Slow steady pumping
- Conserve water
- Learn to share the resource
- Decommission or control flowing artesian wells
- Acreage developments have closely spaced wells, generally all are drilled to a similar depth accessing the same aquifer
- Unsuccessful preventative measures:
  - Drill a deeper well
  - Cistern for water storage



## Water Quality / Water Quantity Downhole Impacts

Naturally occurring minerals

- e.g. Iron and/or manganese, hardness (calcium & magnesium), boron, fluoride, sodium, sulphate, chloride, arsenic, or other metals
- Some water quality parameters can't be seen or smelled such as toxic metals (e.g. arsenic, lead, chromium) – need to test for these.

Impacts may occur through:

- Well casing deterioration
- Biofouling
- Mineral incrustation
- Sediment plugging



# Biofouling – What is it?



- Nuisance bacteria that accumulate in a well.
  - Iron-related bacteria (IRB).
  - Sulphate-reducing bacteria (SRB).
  - Other slime forming bacteria.
- Pumping a well increases nutrients and oxygen leading to an increase in production of slime in groundwater susceptible to bacteria conditions.
- Gradual decrease in well yield and water quality







# **Biofouling - Symptoms**

- Slime build-up on plumbing fixtures.
- Changes in water quality such as:
  - Water discolouration.
  - Staining of plumbing fixtures and laundry.
  - Bad taste and odour (rotten egg smell).
- Gradual decrease in yield.
- Increased corrosion of metal parts in your well and distribution system.





# Biofouling – What You Can Do



- Regularly test your well for bacteria.
- If bacteria found, disinfect your well.
- Contact a Well Driller or Well Pump Installer to clean the well before disinfecting, if needed.



Well Screen After

Well Screen Before



# Mineral Incrustation/Scale – What is it?

- Common in shallow aquifer wells.
- Changes in pressure and temperature during pumping allowing dissolved minerals (calcium, magnesium, iron) precipitate and plug the well intake.
- May also affect aquifer material around the outside of the well.







# Mineral Incrustation / Scale

#### Symptoms:

- Build up of mineral incrustation/scale in your well and on plumbing fixtures.
- Gradual decrease in yield.





## What you can do:

- Perform chemical analysis to determine risk
- Reduce
   pumping rate
- Longer pumping intervals.
- Hire a Well Driller or Well Pump Installer.





# Sediment Plugging – What Is It?

- Sediment plugs well screen and surrounding aquifer.
- Accelerated by:
  - Poor well design and construction.
  - Inadequate development before well is put into production.
  - Over-pumping.





# Sediment Plugging



- Increased sediment in the water
- Decrease in yield
  - Well won't provide the amount of water you're used to
  - Static water level remains unchanged but pumping water level declines.



- What you can do
  - Existing Wells:
    - Reduce pumping rate
    - Provide storage
    - Have a professional look at your well.
  - New Wells:
    - Talk to well driller or well pump installer about proper design and development
    - Have your well system designed to meet your needs based on the well capacity.

# When to Test a Well?

Natural occurring minerals; contamination of bacteria or harmful chemicals



#### Bacteria:

- Early spring
- After any major plumbing work or work done on well or well pump.
- After you move into a new home.
- When you detect any changes in your water quality. e.g.: Clarity, Colour, Odour, Taste.
- When a new child is brought into the home.

## Chemicals & other Parameters\*:

- Test every 3 5 years.
- Test during a dry period.

Note: If there is a treatment system in place the well should be monitored every 2 years for chemicals of concern.

# When to Disinfect a Well?



#### Before Disinfecting , inspect your well.

- Are there any sources of potential contamination near your well?
- Is your wellhead protected?
- Does your well have a secure vermin proof cap?
- Does the well casing stickup at least a foot from the ground?
- Is there an unfilled space or gap between the well casing and the ground around the well?
- Are there any cracks in the surface seal around the well casing?
- Is the well finished below grade?

If you answered "yes" to any of the previous questions

## Fix the problem(s) before disinfecting

- Immediately after installing a new well.
- Whenever you repair or replace your well, pump, or distribution system.
- Following change in water clarity, colour, odour, or taste.
- When lab results show coliform bacteria or *E. Coli* in water.
- When slime is present in toilet tank.



# Groundwater and your well

- Groundwater is shared by your family, your neighbors, and the environment;
- Regularly inspect your well and see if any upgrades or maintenance is required;
- Regularly test your water;
- Keep good records of water levels, water testing, chlorination, and repairs and maintenance, pumping test reports;
- The well is part of the water supply system.

